10/030535 PCT/EP 00 / 06292

The Patent Office

PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS

REC'D 04 SEP 2000

WIPO PCT

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

EP00/06292

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

EJKW

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed Andrew Gersey

Dated 18 April 2000

Patents Form 1/77

Patents Act 1977
(Rule 16)

THE PATENT OFFICE
D
19 JUL 1999
RECEIVED BY POST

The Patent Office

19JUL99 E462685-1 D00866
P01/7700 0.00 - 9916748.8

1/77

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1.	Your reference	GB Case GT/W-21914/P1/AC 524
2.	Patent application number *(The Patent Office will fill in this part)*	19 JUL 1999 — 9916748.8
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	Ciba Specialty Chemicals Water Treatments Limited Cleckheaton Road Low Moor Bradford West Yorkshire BD12 OJZ
	Patent ADP number *(if you know it)*	7585391001
	If the applicant is a corporate body, give the country/state of its incorporation	England
4.	Title of invention	PROCESS FOR THE FLOCCULATION OF SUSPENSIONS
5.	Name of your agent *(If you have one)* "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	MR J W PEATFIELD CIBA SPECIALTY CHEMICALS WATER TREATMENTS LIMITED UK PATENTS DEPARTMENT CLECKHEATON ROAD LOW MOOR BRADFORD WEST YORKSHIRE BD12 OJZ
	Patents ADP number *(if you know it)*	7585391002
6.	If you are declaring priority from one ore more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country / Priority application number *(if you know it)* / Date of filing (day/month/year)
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application / Date of filing (day/month/year)
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *(see note (d))*	Yes

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	-
Description	12
Claim(s)	3
Abstract	1
Drawing(s)	2 a 2 9

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	-
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	-
Any other documents *(please specify)*	-

11. I/We request the grant of a patent on the basis of this application

Signature [signature] Date 15/7/99

12. Name and daytime telephone number of person to contact in the United Kingdom — Mr J W Peatfield..............01274 417401

Warning

After an application for a patent has been filed. the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the united Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *Once you have filled in the form you must remember to sign and date it.*

e) *For details of the fee and ways to pay please contact the Patent Office.*

Process for the Flocculation of Suspensions

This invention relates to processes of flocculating aqueous suspensions in order to effect separation of solids from said suspension.

It is well known to apply polymeric flocculants to aqueous suspensions in order to separate solids from the suspension. For instance it is common practice to flocculate and then dewater suspensions containing either suspended solid organic material or mineral solids. For instance it is common practice to flocculate sludges such as sewage sludge, waste waters, textile industry effluents red mud from the Bayer Alumina process and suspensions of coal tailings etc. Flocculants are also commonly used in paper-making processes by addition of polymeric flocculants to the cellulosic suspension. Flocculation is usually achieved by mixing into the suspension polymeric flocculant, allowing the suspended particles to flocculate and then dewatering the flocculated suspension. In papermaking this removal of water from the cellulosic suspension is often referred to as draining.

High molecular weight polymeric flocculants are commonly used for this purpose. High molecular weight flocculants may be cationic, anionic, nonionic or amphoteric in nature. The choice of polymeric flocculant will largely depend upon the susbstrate, which is being treated. For instance it is common practice to use high molecular weight cationic flocculants to treat aqueous suspensions comprising suspended organic material, for instance sewage sludge. In paper-making it is known to use either cationic, nonionic, anionic or amphoteric flocculants. Flocculation of mineral suspensions is frequently effected by use of anionic flocculants.

It is also known to use two different polymeric flocculants in the same process. The flocculants may have the same charge (co-ionic). For instance in commercial practice in the dewatering sewage sludge these may be co-ionic. In other processes it is known to apply two polymers of opposite charge (counter-ionic). Where two polymeric flocculants are applied to an aqueous suspension they may be added to simultaneously or more usually sequentially.

It is standard practice to apply polymers as aqueous solutions to flocculate suspensions containing suspended organic material. Generally the solutions of polymers are relatively dilute, for instance below 0.5%, often below 0.2% and usually 0.1 to below 0.2% by weight.

Polymers are usually provided as a solid particulate product or as a reverse phase dispersion or emulsion. It is standard practice to dissolve the polymer into water by dispersing the polymer particles in a flowing stream of water in the case of the solid particulate product or in the case of the emulsion or dispersion, inversion into water, by use of activator surfactants. The polymer solution thus formed is frequently at a concentration above 0.3%, often in the range 0.4% to 1% and usually about 0.5%. This more concentrated solution of polymer may be too concentrated to add directly to the suspension in many instances, since received wisdom suggests that there would be inadequate distribution of the flocculant throughout the suspension and as a consequence the flocculation process would be impaired.

It is therefore common practice to first of all provide a more concentrated solution of polymer and then dilute the polymer solution prior to application. Often the diluted solution will have a concentration of below 0.2%, for instance within the range 0.05 to 0.2% by weight and frequently between 0.1 and 0.2% by weight. This dilute solution of polymer is normally metered directly into the suspension prior to the dewatering stage.

There is a desire improve the efficiency of the flocculation processes, to either bring about an increased dewatering effect, such as higher cake solids or in the alternative achieve a constant acceptable level of dewatering efficiency but using a lower dose of flocculant. This is true in a variety of flocculation processes, including dewatering of sewage sludge, slurries of coal tailings, red mud and in papermaking.
It would therefore be desirable to provide an improved method of flocculating and dewatering aqueous suspensions of solids, in particular to provide increased

dryness of the dewatered solids for an equivalent dose of flocculant or to provide the same degree of dryness of dewatered solids but using a reduced dose of flocculant.

The invention relates to a process of flocculating and dewatering an aqueous suspension of suspended solids comprising, introducing into the suspension,

(a) a concentrated polymer solution and,

(b) a dilute polymer solution,

characterised in that the concentrated and dilute polymer solutions are introduced into the substrate substantially simultaneously.

The concentrated and dilute solutions may be metered directly into the suspension as separate solutions. By substantially simultaneously the two solutions should be added at approximately the same dosing point. For instance if the dilute solution is added first the concentrated polymer may be added after flocculation has commenced but should be added before the dewatering stage and before any high shear stage, such as mixing, pumping or screening stages. Preferably the concentrated and dilute polymer solutions are introduced simultaneously.

More preferably the concentrated and dilute polymer solutions are introduced into the suspension as an aqueous composition comprising a dilute aqueous solution of polymer and a concentrated solution of polymer. The aqueous composition should comprise both the dilute and the concentrated polymer solutions as discrete components. Thus it is desired that the dilute solution and concentrated solution exist as substantially discrete components of the aqueous composition.

The aqueous composition preferably comprises the dilute aqueous solution of polymer in an amount of from 40 to 99%, based on weight of polymer, and the concentrated polymer in an amount of from 1 to 60%, based on weight of polymer.

The aqueous composition comprising concentrated and dilute solutions may be of any significantly different concentrations provided that the respective concentrations are not substantially the same such that the two solutions would immediately form a homogenous single solution. Preferably the concentrated solution should be at least twice the concentration of the diluted solution. More preferably the concentrated solution should be at least 4 or 5 times the concentration of the dilute aqueous solution.

The dilute aqueous solution of polymer desirably has a concentration of polymer of below 0.5, preferably below 0.3% by weight. More preferably the concentration of the dilute solution is in the range 0.05 to 0.2%, most preferably around 0.1% by weight.

According to the invention the polymer dissolved in the dilute aqueous polymer solution may be either cationic, anionic or non-ionic.

The concentrated aqueous solution component according to the invention desirably has a concentration of polymer above 0.3% by weight, preferably between 0.4 and 1.0% by weight. More preferably the concentration of the concentrated solution is in the range 0.5 to 1.0%. According to the invention the polymer dissolved in the concentrated aqueous polymer solution may be either cationic, anionic or non-ionic. The polymer dissolved in the concentrated polymer solution is preferably either co-ionic with the polymer dissolved in the dilute solution or non-ionic. In another preferred form the polymer dissolved in the dilute solution is non-ionic and the polymer dissolved in the concentrated polymer solution is cationic, anionic or non-ionic.

When the polymer dissolved in either the dilute solution or concentrated solution is cationic, said cationic polymer may be formed by polymerisation of at least one cationic monomer alone or with other monomers. Suitable cationic monomers include quaternary ammonium or acid salts of monomers which contain amine groups. Preferably the cationic polymer is formed from a monomer or blend of

monomers comprising at least one cationic monomer selected from the group consisting of quaternary ammonium and acid salts of dimethylaminoethyl (meth) acrylate, quaternary ammonium and acid salts of dimethylaminoethyl (meth) acrylamide and diallyldimethyl ammonium chloride. The cationic monomers may be hompolymerised or copolymerised with other monomers, for instance acrylamide. In addition to vinyl addition polymers, the cationic polymer may include polymers obtained by condensation or addition reactions. For instance suitable cationic polymers include adducts of amines with epihalohydrins or dihaloalkanes, polyamides and polethylene imines.

In the case where the polymer dissolved in either the dilute solution or concentrated solution is anionic, said anionic polymer may be formed by polymerisation of at least one anionic monomer alone or with other monomers. Suitable anionic monomers include ethylenically unsaturated monomers comprising carboxylic acid or sulphonic acid groups. Preferably the anionic polymer is formed from a monomer or blend of monomers comprising at least one anionic monomer selected from the group consisting of (meth) acrylic acid, 2-acrylamido-2-methylpropane sulphonic acid, alkali metal and ammonium salts thereof.

If the polymer dissolved in either the dilute solution or concentrated solution is nonionic, said anionic polymer may be formed by polymerisation of suitable non-ionic monomers, for instance acrylamide or methacrylamide.

The polymers suitable for both the concentrated aqueous solution and dilute aqueous solution may be prepared by any convenient polymerisation process, for instance gel polymerisation, reverse phase suspension polymerisation, reverse phase emulsion polymerisation, solution polymerisation and the like. Thus suitable polymers may be provided in the form of granulated powders, beads, reverse phase emulsions, reverse phase dispersions or aqueous solutions.

The concentrated aqueous solution may be formed by dissolving any suitable water soluble polymer into water. The dilute aqueous solution of polymer may also be prepared by dissolving any suitable water soluble polymer into water or alternatively by diluting a more concentrated solution of the polymer solution. The respective concentrated and dilute aqueous solutions may be produced therefrom by known dissolution, inversion or dilution techniques as appropriate. For instance solid particulate cationic polymer may be dissolved by dispersing the polymer particles into a flowing stream of water. Reverse phase emulsions or reverse phase dispersions of cationic polymers may be inverted into water by use of activator surfactants to form the respective aqueous solutions. Preferably the polymers dissolved in both the dilute and concentrated solutions are essentially the same polymer.

The polymers according to the invention may be prepared as substantially linear polymers or as branched or structured polymers. Structured or branched polymers are usually prepared by inclusion of polyethylenically unsaturated monomers, such as methylene-bis-acrylamide into the monomer mix, for instance as given in EP-B-202780. Preferably however, the polymers are substantially linear and are prepared in the form of a bead or powdered product.

A particularly preferred group of polymers includes copolymers of acrylamide with at least one cationic monomer selected from the group consisting of quaternary ammonium and acid salts of dimethylaminoethyl (meth) acrylate, quaternary ammonium and acid salts of dimethylaminoethyl (meth) acrylamide and diallyldimethyl ammonium chloride, having an intrinsic viscosity of at least 4 dl/g. The cationic acrylamide polymers may comprise 10 to 90% by weight acrylamide and 10 to 90% by weight cationic monomer(s).

The aqueous composition comprising the dilute aqueous solution of cationic polymer and the concentrated solution of cationic polymer may be formed by introducing the concentrated solution of cationic polymer into a flowing stream of the dilute aqueous solution of cationic polymer. For instance in one method of

preparing the aqueous composition a concentrated aqueous solution of cationic polymer is introduced directly into a conduit through which the dilute aqueous solution of cationic polymer is being conveyed towards the dosing point where the aqueous composition comprising both concentrations of polymer are metered into the suspension of solids in order to effect flocculation.

According to a preferred form of the invention wherein an aqueous suspension of suspended solids is flocculated and dewatered, an aqueous composition is introduced into the suspension. The aqueous composition comprises concentrated and dilute aqueous solutions of cationic polymer wherein the two solutions exist as discrete components of the composition. It is considered desirable that the mixture of concentrated and dilute solutions exist together as a non-homogenous composition. Therefore, in order to prevent the concentrated solution from dissipating and being diluted thus forming a homogenous solution of polymer at a single concentration, it is desirable to substantially reduce any mixing of the aqueous composition prior to being introduced into the suspension. One way that undesirable mixing of the aqueous composition can be avoided is by ensuring that there are no mixing or pumping stages after the concentrated and dilute solutions have been combined. In addition it may further be desirable for the conduit to have a relatively smooth inner surface and the avoidance short radius bends, for example as given in pending International Application No. PCT/GB 99/00990. Another way that undesirable mixing can be avoided is to reduce the distance the aqueous composition has to travel by combining the concentrated and dilute solutions relatively close to the dosing point.

It is desirable that the aqueous composition comprising dilute and concentrated solutions does not contain substantial amounts of undissolved polymer, for instance it is preferable that less than 5%, more preferably less than 2% by weight of total polymer contained in the aqueous composition is not in solution. In many dewatering situations the most efficient use of the polymer is achieved if the amount of undissolved polymer is less than 1%, especially less than 0.5%.

The dilute solution of cationic polymer may conveniently be prepared by dilution of a more concentrated solution of the polymer. This can be achieved by adding dilution water to a flowing stream of more concentrated solution of polymer. For instance it may be desirable to pass the more concentrated solution of cationic polymer along a conduit to a dilution stage, where dilution water is introduced into the concentrated solution. In order to achieve adequate mixing of the concentraed solution with the water so that a homogenous consistent dilute solution is obtained it may be necessary to introduce a mixing stage. The mixing stage may be for instance an in-line mixing stage, such as an in-line static mixer, a pumping stage, a screening stage or some other means that can ensure adequate mixing. Preferably once thoroughly mixed the diluted solution will be substantially homogenous.

A particularly preferred aspect of the invention relates to a process of flocculating and dewatering an aqueous suspension of suspended solids by introducing into the suspension an aqueous composition comprising concentrated and dilute polymer solutions wherein the aqueous composition is formed by,
(a) passing a concentrated solution of polymer to a dilution stage where the solution is combined with dilution water to form a dilute solution,
(b) passing the diluted solution through a mixing stage, selected from an in-line mixer, a pumping stage and screening stage, and
(c) introducing a concentrated solution of polymer into the dilute aqueous solution.

The concentrated polymer solution, which is diluted to form the dilute polymer solution may be drawn from the same reservoir of concentrated polymer solution which is subsequently mixed with the dilute solution in forming the said aqueous composition according to the invention.

Thus in a particularly preferred process for preparing the aqueous composition a concentrated aqueous solution of cationic polymer contained in a holding vessel is passed through a conduit to a dilution stage and subsequent mixing stage thus

providing the dilute aqueous solution. Concentrated aqueous solution of cationic polymer contained in the holding vessel from said holding vessel is passed by means of a second conduit directly into the dilute aqueous solution of cationic polymer. A typical arrangement for carrying out the preparation of the aqueous composition according to this aspect of the invention is shown in Figure 1.

In Figure 1 the following key applies,

[1] Holding vessel containing concentrated cationic polymer solution

[2] Conduit conveying concentrated cationic polymer solution to dilution stage

[3] Dilution water line

[4] Pump

[5] Conduit conveying dilute cationic polymer solution

[6] Conduit conveying concentrated polymer solution

[7] Aqueous composition comprising concentrated and dilute aqueous solutions of cationic polymer

[8] Sewage sludge line

[9] Dewatering stage

[10] Dosing point of aqueous composition into the sludge

[11] Dilution stage

[12] Pump

Thus in the scheme represented in Figure 1, aqueous concentrated cationic polymer solution is held in holding vessel [1]. Concentrated polymer solution is passed along conduit [2] towards dilution stage [11] after which the aqueous polymer solution and dilution water passed through a pump [4] where they are mixed together to ensure that a consistent diluted polymer solution is formed. The dilute aqueous polymer solution is passed along conduit [5] towards the point where concentrated polymer solution is added. A second conduit [6] from holding vessel [1] conveys concentrated cationic polymer solution into the dilute polymer solution to form the aqueous composition [7] which is passed to the dosing point [10] where the mixture of concentrated and dilute cationic polymer solutions are metered into the sewage sludge line [8]. The treated sewage sludge is then

passed into the dewatering stage [9].

Alternatively the concentrated polymer solution which is combined with the dilute aqueous polymer solution may be drawn from a separate reservoir of concentrated polymer solution from that which is diluted to form the dilute aqueous polymer solution. Thus in this alternative form of the invention the opportunity exists for the concentrated polymer being a different polymer from the polymer in the dilute aqueous solution. For instance it may be desirable to combine a concentrated solution of a low molecular weight cationic polymer, having an intrinsic viscosity of below 3dl/g, with a dilute solution of a high molecular weight cationic polymer, having an intrinsic viscosity of at least 4 dl/g. The low molecular weight polymer may be a coagulant, for instance the hompolymer of diallyldimethyl ammonium chloride. The high molecular weight polymer may be a bridging flocculant, for example a copolymer of acrylamide with a suitable cationic monomer, such as the quaternary ammonium salt of dimethylaminoethyl (meth) acrylate. A typical arrangement for conducting this alternative aspect of the invention is shown in Figure 2.

In Figure 2 the following key applies,

[1] Holding vessel containing concentrated cationic polymer solution
[2] Conduit conveying concentrated cationic polymer solution to dilution stage
[3] Dilution water line
[4] Pump
[5] Conduit conveying dilute cationic polymer solution
[6] Second holding vessel for concentrated cationic polymer solution
[7] Conduit conveying concentrated polymer solution
[8] Aqueous composition comprising concentrated and dilute aqueous solutions of cationic polymer
[9] Sewage sludge line
[10] Dewatering stage
[11] Dosing point of aqueous composition into the sludge

[12] Pump

[13] Dilution stage

Thus in the scheme represented in Figure 2, aqueous concentrated cationic polymer solution is held in holding vessel [1]. Concentrated polymer solution is passed along conduit [2] towards dilution stage [13] after which the aqueous polymer solution and dilution water are passed through a pump [4] where they are mixed together to ensure that a consistent diluted polymer solution is formed. The dilute aqueous polymer solution is passed along conduit [5] towards the point where concentrated polymer solution is added. A second conduit [7] passes concentrated aqueous cationic polymer solution from holding vessel [6] into the dilute polymer solution to form the aqueous composition [8] which is passed to the dosing point [11] where the mixture of concentrated and diluted cationic polymer solutions are metered into the sewage sludge line [9]. The treated sewage sludge is then passed into the dewatering stage [10].

The invention is suited to a variety of processes involving flocculation and dewatering. Processes of particular relevance include dewatering sewage sludges, dewatering mineral suspensions and papermaking processes.

The following example is an illustration of the invention.

Example

Aqueous solutions of a copolymer of acrylamide with dimethylaminoethyl methacrylate, methyl chloride quaternary ammonium (40/60 weight/weight), intrinsic viscosity at least 10dl/g, are prepared at 0.1, 0.125 and 0.5% concentration.

Composition 1 is prepared by mixing 0.1% solution with 0.5% solution on a 50/50 weight/ weight basis. Composition 2 is prepared by mixing 0.1% solution with 0.5% solution on a 75/25 weight/ weight basis.

200ml aliquots of Rotherham (Yorkshire, England) sewage sludge are treated with dilute polymer (0.1%) and (0.125%), concentrated polymer (0.5%) and using composition 1 and composition 2 each at various doses of cationic polymer. The treated sludge is mixed at 2000 rpm for 15 seconds. The flocculation efficiency is measured by free drainage using a 10cm diameter sieve.

The free drainage results are shown in Table 1

Table 1

Polymer solution	5 second filtrate volume (ml) for each dose		
	137.5 mg/l	150 mg/l	162.5 mg/l
0.1%	10.5	31	55
0.125%	4	24	50
0.5%	-	27	49
Composition 1	19	41	79
Composition 2	14	32	67

The results clearly show the advantage of using the compositions comprising a mixture of concentrated and dilute solutions of the cationic polymer.

Claims

1. A process of flocculating and dewatering an aqueous suspension of suspended solids comprising, introducing into the suspension,

(a) a concentrated polymer solution and,

(b) a dilute polymer solution,

characterised in that the concentrated and dilute polymer solutions are introduced into the substrate substantially simultaneously.

2. A process according to claim 1 in which the concentrated polymer solution and dilute polymer solution are introduced into the suspension as an aqueous composition comprising,

(a) a dilute aqueous solution of polymer and,

(b) a concentrated solution of polymer,

wherein the dilute solution and concentrated solution exist as substantially discrete components.

3. A process according to claim 2 in which the aqueous composition comprises,

(a) 40 to 99%, by weight of the dilute aqueous solution of polymer and,

(b) 1 to 60% by weight of the concentrated solution of polymer.

4. A process according to any of claims 1 to 3 in which the dilute aqueous solution has a concentration of polymer of below 0.3% by weight.

5. A process according to any one of claims 1 to 4 in which the dilute aqueous polymer solution comprises a cationic polymer, an anionic polymer or a nonionic polymer.

6. A process according to any of claims 1 to 5 in which the concentrated aqueous solution has a concentration of polymer of between 0.4 and 1.0%, by weight.

7. A process according to any one of claims 1 to 6 in which the concentrated aqueous solution comprises a cationic polymer, an anionic polymer or a nonionic

polymer.

8. A process according to any one of claims 1 to 7 in which the polymer dissolved in the concentrated solution is either co-ionic with the polymer dissolved in the dilute solution or non-ionic.

9. A process according to any one of claims 1 to 8 in which polymer dissolved in either the dilute solution or the concentrated solution is cationic and has been formed from a monomer or blend of monomers comprising at least one cationic monomer selected from the group consisting of quaternary ammonium and acid salts of dimethylaminoethyl (meth) acrylate, quaternary ammonium and acid salts of dimethylaminoethyl (meth) acrylamide and diallyldimethyl ammonium chloride.

10. A process according to any one of claims 1 to 9 in which the polymer(s) dissolved in either the dilute solution or the concentrated solution is anionic and has been formed from a monomer or blend of monomers comprising at least one anionic monomer selected from the group consisting of (meth) acrylic acid, 2-acrylamido-2-methylpropane sulphonic acid, alkali metal and ammonium salts thereof.

11. A process according to any one of claims 1 to 10 in which the polymer(s) dissolved in either the dilute solution or the concentrated solution is nonionic and has been formed from acrylamide or methacrylamide.

12. A process according to any one of claims 1 to 11 in which the cationic polymer dissolved in each of the dilute and concentrated aqueous solutions is a copolymer of acrylamide and at least one cationic monomer selected from the group consisting of quaternary ammonium and acid salts of dimethylaminoethyl (meth) acrylate, quaternary ammonium and acid salts of dimethylaminoethyl (meth) acrylamide and diallyldimethyl ammonium chloride, having an intrinsic viscosity of at least 4 dl/g.

13. A process according to any one of claims 2 to 12 in which the aqueous composition comprising the dilute aqueous solution of polymer and the concentrated solution of polymer is formed by introducing the concentrated solution of polymer into a flowing stream of the dilute aqueous solution of polymer.

14. A process according to claim 13 in which the dilute aqueous solution of polymer is formed by diluting a flowing stream of the concentrated aqueous solution of polymer with dilution water.

15. A process according to any one of claims 2 to 14 in which the aqueous composition is formed by,
(a) passing a concentrated solution of polymer to a dilution where the solution is combined with dilution water to form a dilute solution,
(b) passing the diluted solution through a mixing stage, selected from pumping and screening stages, and
(c) introducing a concentrated solution of polymer into the dilute aqueous solution.

16. A process according to claim 15 in which the concentrated polymer solution, which is diluted to form the dilute polymer solution in step (a) is drawn from the same reservoir of concentrated polymer solution introduced into the dilute solution in step (c).

17. A process according to claim 15 in which the concentrated solution of polymer in step (a) is drawn from a different reservoir of concentrated polymer solution introduced into the dilute solution in step (c).

18. A process according to any one of claims 1 to 17 in which the dewatering process is selected from the group consisting of dewatering sewage sludge, dewatering a mineral suspension and a papermaking process.

Abstract

A process of flocculating and dewatering an aqueous suspension of suspended solids comprising, introducing into the suspension,

(a) a concentrated polymer solution and,

(b) a dilute polymer solution,

characterised in that the concentrated and dilute polymer solutions are introduced into the substrate substantially simultaneously.

Figure 1

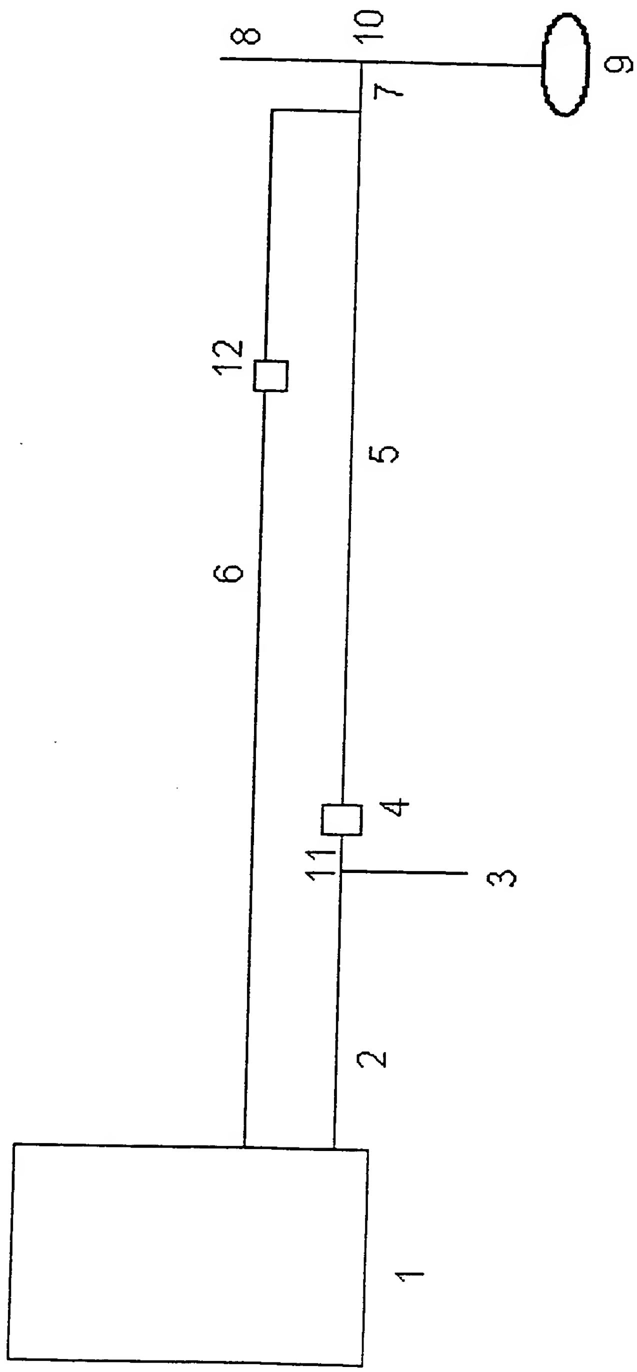
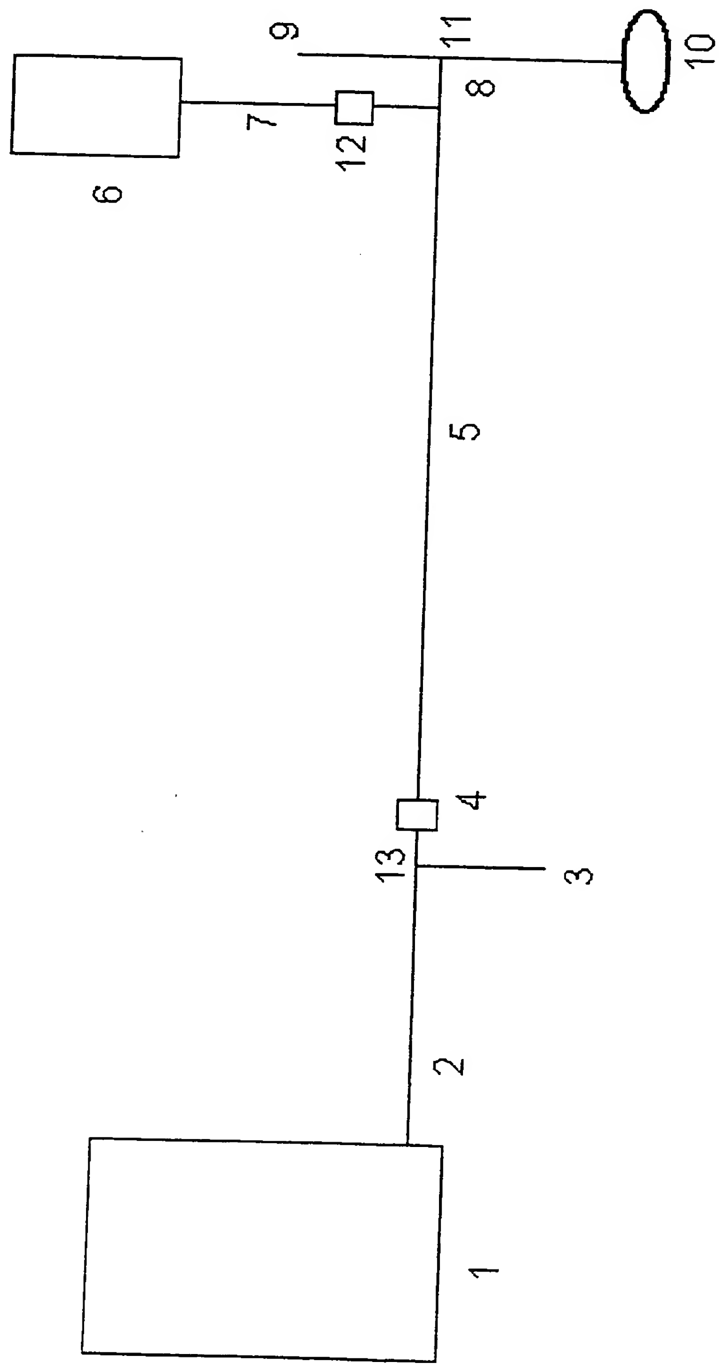


Figure 2



INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/06292

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C02F1/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 95 33697 A (ALLIED COLLOIDS) 14 December 1995 (1995-12-14) page 14, line 18-25; claims 1-12	
A	DE 30 20 685 A (ALBERT GUENTHER) 10 December 1981 (1981-12-10) claims 1-18	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 November 2000	14/11/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Fouquier, J-P

1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/06292

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9533697 A	14-12-1995	AT 172700 T	15-11-1998
		AU 2677795 A	04-01-1996
		DE 69505665 D	03-12-1998
		DE 69505665 T	25-03-1999
		DK 764140 T	12-07-1999
		EP 0764140 A	26-03-1997
		ES 2124555 T	01-02-1999
		US 5846433 A	08-12-1998
		ZA 9504744 A	10-06-1996
DE 3020685 A	10-12-1981	NONE	